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Tankless Water Heaters

From The Editor . . .

The construction industry, unlike other industries, relies to a large extent on public sector support for fundamental research support. That is why research done by and supported by public sector bodies like CMHC, NRCan and the National Research Council are vital.

Although the industry is large - the housing industry alone represents more than $100 billion dollars to the Canadian economy, accounting for over 6% of Canada's GDP – the make-up of the industry means there are no large vertically integrated corporations. Contractors are assemblers of components, and at the end of the day, build serial prototypes on a project-by-project financing basis, so there are very limited resources to undertake research.

The major housing sector research and information dissemination agency to date has been CMHC. By law, CMHC is obligated to conduct research into the social, economic and technical aspects of housing, and to publish and distribute the research results. It has been the key agency supporting housing research and information dissemination – much envied in other countries, even though the total budget for research has been peanuts compared to the corporate revenues.

By government fiat this year the corporation has been told to reduce expenses. Never mind whether it makes sense or not, or that it is a very profitable self-financing corporation with a 2011 net income of more than $1.5 billion. As a result, CMHC has, for all intents, eliminated research and information dissemination. Funding to the research division will be slashed by $9.76 million per year (with a reduction of 26 staff), as well as funding to the National Housing Research Committee. The few research officer positions left will be a token research division, without the critical mass to be able to properly manage meaningful research.

They are also discontinuing any further funding for Equilibrium housing and community demonstration activities, as well as any research and information transfer activities on sustainable communities. CMHC will also discontinue research on the design and construction of new high-rise multi-unit buildings. As research activities are slashed, so will CMHC marketing support for consumer and industry publications. What the cuts are doing is to weaken or eliminate the one centralized critical and knowledgeable source of information for our industry.

That such an important industry is getting short shrift from the Harper government, as the current Canadian federal government wants to be called, should be a call to arms for the industry. Yet it's disturbing to see so little reaction from the housing industry. Builders should be storming their MPs and federal ministers to protest these policies that are going to have significant impacts on the industry. We should be standing on the rooftops and let it be known that such actions are short-sighted and will only harm the industry.

While we understand the need to be prudent and fiscally responsible, the actions the government has forced are completely irresponsible. In the modern world, knowledge and innovation are key. Today we are seeing drastic changes in the way we build homes, driven by the desire for environmentally superior, high performance net-zero energy construction. Public expectations for performance and quality are much higher. But there can be unintended consequences when changes are made – what may work in one region may not elsewhere. Although basic building science may be constant, local climatic, geographical and social conditions differ and require special scrutiny and analysis.

As we change what and how we build, we must be vigilant to ensure that mistakes are not made – that's where research becomes fundamental. Information dissemination in this huge country is difficult at best, making it difficult to learn lessons from one place to another – even in the Internet age.

Privately funded research may do some of work, but we know that results are not always freely disseminated. It is often kept under wraps because it does not fit the corporate policy, proves something doesn't really work, or to keep a competitive advantage. But come to think of it, keeping everything under wraps, and discounting scientific research is how the Harper government conducts public business.

Builders should aggressively protest this turn of events, as it will harm the industry. At one time we were world leaders in advanced homebuilding construction – now we're being passed by the rest of the world. We're already starting to import products and technologies that originated in Canada.

Richard Kadulski,
Editor

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Tankless Water Heaters

About 30% or more of the average home's energy consumption is used for heating domestic water. The proportion increases in very energy efficient homes. Until recently, most North American homes have been equipped with storage-type hot water systems. Storage-type systems receive cold potable water into a storage tank where it is then heated, either by electric elements or fuel-fired (gas or oil) heat exchangers. Heat can also be added to the tank from solar, geothermal or air source heat pump systems.

In the last several years, tankless water heaters, also known as "on-demand" or "instantaneous" water heaters, have been introduced into the North American market. Although these are new in North America, they are the common hot water heating technology in Europe and Asia.

As the name implies, tankless heaters do not heat hot water in storage tanks. Tankless units are more compact than storage-type water heaters and they are typically wall-hung and therefore require less floor space. Rather, they use high inputs of gas or electricity to instantaneously heat water as it flows through the unit. Some tankless water heaters have features that can condense moisture from the combustion gases to increase energy efficiency. As water heating only occurs on demand, tankless heaters do not heat hot water when it is not needed and they do not incur standby heat losses typically associated with conventional storage-type hot water heaters.

The heat-on-demand, no standby energy loss features of tankless water heaters can be expected to reduce hot water-related energy consumption, but little data is available about the actual energy savings of tankless water heaters compared to conventional hot water tanks.

Although the tankless heaters are energy-efficient, operational aspects may affect their overall performance. When a tap is opened, a small amount of cold water is fed through the unit – this allows it to gauge the incoming water temperature to determine how much energy is needed – so there may be a lag.

Once started, it may also take the heating unit some finite time to become fully operational. This can result in a delay of hot water arriving at the tap which can be frustrating for the user and may also result in the waste of water as the user waits for the hot water to arrive. Additionally, the capacity of tankless water heaters to provide "endless" hot water for showers may lead some users to consume more hot water than they otherwise would (or could) with storage-type water heaters given their reduced capacity to instantaneously heat water.

Consumer Reports magazine found that some people complained about inconsistent water temperatures. In addition, the burner of a water heater might not ignite under a very low flow condition.

Because the tankless units have electric controls, hot water capacity will be lost during a power outage, although some units now have micro turbines that generate their own power when water flows past the unit, thus becoming autonomous of the grid.

Because there is little information on the relative performance of storage and tankless water heaters, Canada Mortgage and Housing Corporation (CMHC) in collaboration with Enbridge Gas initiated a research project to answer the following questions:

1. Do gas-fired tankless water heaters result in less gas being used for water heating than their storage tank alternatives? If so, how much?
2. Is there a difference in the amount of water used by a family with a new tankless water heater, compared to the family's old usage with the storage-type heaters? If so, how much?
3. Are there any other notable differences in how occupants perceive the performance of tankless and storage-type water heaters?

The study identified a number of houses in Ontario where the owners indicated a desire to switch from storage-tank water heaters to tankless units. The number of occupants averaged 3.5 per house, and the pre-retrofit storage-type heaters ranged in age from 2 years to over 25 years with an average age of 10.2 years. Just

over 70 per cent of the storage tanks were being rented by the homeowners – a common practice in Ontario.

Hot water use was measured with water meters installed on the inlets to the water heaters and natural gas meters were installed to measure the natural gas consumed by the water heaters. After a three-month monitoring period, the storage-type heaters were removed and replaced with tankless water heaters and monitoring then continued for another three months. Hourly gas and hot water use data, pre- and post- installation of the tankless water heaters, were then analyzed.

The gas consumption data were adjusted to remove the impact of typical changes in water heater energy consumption due to seasonal changes in the water temperature delivered from the water mains.

Surveys were conducted to gauge homeowner impressions of the performance of their new tankless water heaters and to determine if there had been any changes in the households during the study period that would have impacted on hot water consumption during the pre- and post-retrofit monitoring periods.

The impact that the hot water heaters may have had on space heating and cooling energy consumption was not considered. The storage-type heater standby heat losses can partially offset some space heating requirements in winter and but they add to air-conditioning loads in the summer. Thus the overall household natural gas savings resulting from a conversion from storage-type to tankless water heaters may not be as large as the natural gas savings found in this study.

Overall, on average there was a 46-per-cent reduction in natural gas used for water heating after the installation of the tankless water heaters. Although the condensing tankless units are designed to be more energy efficient, on average, the non-condensing tankless heaters saw the greatest energy savings. However, the sample size was small, so no definitive conclusions about the performance difference could be made. Some of the difference was accounted for by changes in water consumption. Several homes with the non-condensing tankless heaters achieved greater natural gas savings because their usage of hot water decreased by an average of 13 per cent, compared to an average increase in water consumption of 5 per cent for the houses with the condensing units.

There was an average 2 percent increase in overall hot water use after the installation of the tankless water heaters. The availability of an endless supply of hot water might explain the increases in hot water use – in two of the houses it increased more than 50%.

Based on the results of the CMHC study, replacing the existing natural gas-fired, storage-type water heaters with gas-fired tankless water heaters can result in significant natural gas savings for water heating. On average, 0.63 m^3/day (23 MJ/day) or 230 m^3/year (8.62 GJ/year) of natural gas was saved. At \$0.30/m^3, this translates to an average savings of \$69 per year.

Homeowners tended to respond positively to the endless supply of hot water delivered by tankless water heaters, although some reservations were expressed regarding how long it took for hot water to arrive at the faucet and the cost of the units.

Fourteen of 25 survey respondents expressed that the "endless" hot water was something they liked about the tankless system, while 10 respondents indicated that they enjoyed the energy savings. Fourteen of the 25 survey respondents expressed a dislike for the increase in the time it took to get hot water to the tap with the tankless heaters – the average increase in time delay to get hot water at the tap was reported to be around 20 seconds, although this didn't seem to have a significant impact on hot water consumption.Careful design and installation of tankless water heating systems may help overcome issues related to hot water delivery time.

Tankless Water Heater Testing at CCHT

In late 2004, Enbridge Gas Distribution Inc, Union Gas Ltd and Natural Resources Canada established a research project with the Integrated Energy Systems Laboratory and the Canadian Centre for Housing Technologies (CCHT) to assess the relative energy performance of a tankless natural gas-fired system, as compared with conventional domestic hot water installations. The tankless system was installed and commissioned in a single-detached Test House at CCHT.

In June and November of 2005, the tankless water heater was tested with imposed domestic hot water loads through simulated occupancy protocol. Its energy performance was compared to the energy performance of a reference water heating system, a storage-type power-vented water heater, installed in the Reference House at CCHT.

However, because this was commercially funded research, the test results report is considered to be a Confidential Client Report, so the results are not available.

It was also noted that the installation of tankless water heaters may lead to an increase in hot water usage as occupants respond to availability of a continuous supply of hot water, although the extent of any such increase would be highly dependent on how individual occupants use hot water.

Tankless units might need more care as they need to be serviced periodically, especially in certain water conditions. There could be scale build-up because of turbidity in the water or calcium build-up in hard water that can lead to sediment build-up in the pipes decreasing efficiency and restricting water flows. In addition, because of their more sophisticated design, there are more mechanical components that may require periodic servicing.

Cost is a major concern with tankless water heaters as they cost two to three times that of conventional storage tank water heaters which have become replaceable commodity items. Even though storage tank water heaters may have a shorter life – sometimes as short as 7-10 years – and are not as efficient, they are relatively inexpensive to install and replace compared to the tankless units, especially in retrofit applications.

In new construction, the system layout can be designed to minimize some of the performance and maintenance issues. In the Vancouver area, many higher-end homes built today have combination systems utilizing tankless water heaters to supply the space and domestic hot water needs for the home. ☼

Monitoring Performance of Retrofitting from Tank to Tankless Water Heaters
CMHC Research Highlight – Technical Series - 11-101

Actual Savings and Performance of Natural Gas Tankless Water Heaters

A study for the Minnesota Office of Energy Security found a 37% savings of water heating energy per household for replacing a typical natural draft storage water heater with a tankless one. Tankless water heaters saved energy and provided homeowners with acceptable hot water service at a reduced monthly cost without increasing total hot water consumption.

Although tankless water heaters have a high incremental cost, they have achieved about 5% of the new water heater market in the US.

Gas Fireplaces

The Impact of Gas Fireplace Operation on Energy Consumption and House Temperatures

Gas fireplaces have become a common feature in today's homes. The 2007 NRCan Survey of Household Energy found that almost a quarter of all homes reported having a gas-burning fireplace. Of these homes, 22% reported using the fireplace every day during the heating season.

Since the fireplace is usually in the main living area of the house, and often near the home's heating system thermostat, the heat from the fireplace can affect the heating system and its operation, affecting energy consumption and temperatures in the home. Sometimes, gas fireplaces are even used as part of the heating system by design. The effect of fireplace operation will vary depending on house size and layout.

To find out the impact of operating a gas fireplace on an energy efficient R-2000 house, tests were carried out at the National Research Council's Canadian Centre for Housing Technology (CCHT) in Ottawa. This facility features two identical, highly instrumented R-2000 homes with simulated occupancy to evaluate the whole-house performance of new technologies in side-by-side testing.

The fireplace used in the study was a 20,000 BTU/hr direct-vent, natural gas, zero clearance fireplace with a standing pilot light and 48 W fan and a measured steady state efficiency of 76%. The fireplace was operated with several scenarios during December:

Evening operation – 6 pm to midnight with the furnace fan shut off when not in high speed heating mode;

Continuous operation controlled by a dedicated thermostat set 2°C above that of the main heating system and the furnace fan providing continuous air circulation when not in high speed heating mode.

Continuous pilot light operation only (24 hours/day) with the furnace fan providing continuous air circulation when not in high speed heating mode.

Evening operation

Evening operation of the fireplace resulted in an increase in natural gas consumption whether or not the furnace fan was running continuously. Natural gas consumption of the house increased by 36 MJ/day (or 16%). Although the gas consumption of the furnace decreased because of the heat contributed by the fireplace, it was more than offset by the gas consumption of the fireplace (about 144 MJ/day).

Thermostat controlled

When the fireplace was operated by a thermostat, the furnace worked much less, largely because the thermostat was quite close to the fireplace. The fireplace consumed 249 MJ/day of natural gas and 1.28 kWh/day of electricity, and reduced furnace consumption by 208 MJ/day (59%) of natural gas and 2.13 kWh/day of electricity for an overall increase of 38 MJ/day (10%) in total heating energy consumption.

This project highlights the need for careful consideration of thermostat placement. When the thermostat is close to the fireplace, operating the fireplace can reduce the thermostat's call for heat, and result in substantially cooler temperatures in distant rooms.

Evening operation of the fireplace warmed the family room well above the temperature set-point of the furnace thermostat (22°C), at times exceeding 25°C. However, at that time the air temperature in the second floor bedrooms dipped by as much as 2°C, resulting in a temperature difference between rooms of up to 8°C. This was most pronounced in the bedrooms furthest away from the fireplace location. It didn't matter whether the furnace fan was running continuously or not, which suggests that the furnace fan was not effective at moving heat from the warm room with the fireplace to the second floor.

The CCHT houses feature an open plan layout with the fireplace close to the central thermostat. A closed layout and/or the fireplace located far from the thermostat would reduce the interaction with the central heating system.

The house thermostat setting during the fireplace experiments was 22°C. A lower setting, or a thermostat setback with fireplace operation could result in lower room temperatures in locations far from the fireplace.

It is also important to note that the CCHT houses are unfurnished. In a furnished house, the contents add thermal mass that would affect the time taken for the house to adapt to changes in temperature.

Wall surface temperatures were also measured. Although there were daily fluctuations in the house as the fireplace warmed the family room, the wall surface temperatures on the second floor didn't change much. The coolest location was in a second floor bedroom closet, where the minimum surface temperature was reduced by 0.7°C due to fireplace operation. The lowest temperature reached at this location was 12.8°C. At this temperature, air at 21°C with 59% humidity would be expected to condense. Effects at the other locations were minimal.

The minimal temperature fluctuations of wall surfaces would be accounted for by the thermal storage of the construction materials, and the fact that the furnace was operating normally for the remaining 18 hours. A lower house set-point temperature or daily house thermostat setback in combination with fireplace operation would reduce furnace on-time, and could potentially lead to lower wall surface temperatures.

The CCHT houses are built to R-2000 standards, with a continuously operating heat recovery ventilator, so they hold heat better than older houses. Fireplace operation in a house with lower quality windows and insulation could lead to lower air and surface temperatures in locations far from the fireplace.

Impact of Pilot Lights

The pilot light alone also impacted furnace operation. The total impact on heating energy (electrical and gas) consumption was a net increase of 18 MJ/day (5%) due to pilot light operation. However, the impact of pilot light operation on room temperatures was minimal – a temperature increase in the family room (where the fireplace was located) of about 0.3°C and a temperature decrease on the second floor of the house of about 0.2°C.

Even when the fireplace was not in operation, the pilot light alone showed some influence on the central heating system, and increased total heating energy consumption. An intermittent or automatic electric ignition system would eliminate the need for a pilot light, and would result in substantial energy savings.

Conclusions

Through these experiments, fireplace operation was shown to have a significant impact on increasing total house heating energy consumption and lowering air temperatures in far away rooms. The impact of fireplace operation will be different depending on house design and mechanical system. The increase in overall gas consumed when the fireplace is used is largely due to the lower efficiency of gas fireplaces compared to the efficiency of the high-efficiency condensing gas furnace.

The large temperature swings that would be experienced by someone moving from room to room in the home could have a negative impact on comfort. ☼

The Impact of Gas Fireplace Operation on Winter Energy Consumption and House Temperatures *CMHC Research Highlights Technical Series 11-100*

For more information about the CCHT facilities www.ccht-cctr.gc.ca.

CSA P.4.1-09 Testing Method for Measuring Annual Fireplace Efficiency

This CSA standard provides a method for measuring the efficiency of natural gas fireplaces. A number of concerns have been expressed about the testing criteria, so the standard is being revised with an estimated publication date in early 2014.

Upgrades would address identified issues in the original standard. These include a potential error in the calculation of the energy efficiency as it was possible for fireplaces having a higher pilot light to have a benefit over fireplaces having a lower pilot input. When fitted with a pilot, the on/off cycle times currently used in the standard may need to be revised. As well, the electrical energy consumption of a fireplace should be considered for inclusion in a performance metric, and a means of measuring and rating the radiant output of gas fireplaces needs to be considered.

Energy Answers

What do you think of using granite countertops as a source of thermal mass in homes?

Additional thermal mass is generally beneficial in homes to limit temperature rise from passive solar gains and internal heat gains; I just don't like granite countertops for a number of reasons:

1. A number of the sources of granite are emitters of radon gas, a deadly carcinogen. It is very difficult to tell which granites are sources of radon. We have enough cancer as it is.

2. The amount of added thermal mass from granite countertops in a typical home is very small. A typical house has a thermal mass of about 20 megajoules per degree C primarily from the gypsum board and the wood framing. A 20-foot long granite countertop 2 feet wide and 2 inches thick would only add about 0.24 megajoules per degree C of heat capacity, or just over 1% more to a typical house.

3. A fair amount of the granite is imported from China and India. Thus the embodied energy of the granite is quite high because of transport energy.

4. The granite top surface needs periodic refinishing, which would add volatile organic compounds to the air in the house.

5. Granite is very expensive relative to more conventional surfaces such as melamine.

6. My sister is a nurse practitioner, and she tells me that the morgues in hospitals typically use granite countertops. It's kind of a creepy material.

For all the above reasons, I would not put granite countertops in a house. If you love the look of granite, you can buy laminate countertops that look like granite.

My favourite thermal mass addition in wood frame houses is to place scrap gypsum board in the hollow wall cavities. This solves two problems: reducing solid waste to the landfills and adding inexpensive thermal mass. ☼

Rob Dumont

Canadian
Home Builders'
Association

Technical Research Committee News

CSA Standards

CSA Standards are updated regularly, and new ones developed as the need arises to deal with new technologies. Standards may be cumbersome, but they do make it easier for professionals and regulators to accept new technologies. Recently developed standards, or standards that are in development, address technologies that are increasingly being seen with new sustainable developments.

CSA B65-12 Installation Code for Decentralized Wastewater Systems.

This new Code covers decentralized wastewater systems that use soil absorption systems for infiltration, dispersal, and final treatment of wastewater. This applies to residential, institutional, and commercial systems, and also covers sewage holding tanks.

CSA B126 Water Cisterns

A series of Standards that will address potable and non-potable water cisterns, including general requirements, methods of testing, installation and commissioning, field inspection, operation and maintenance, decommissioning, and mobile water cisterns. This standard is expected to be published early 2013.

CSA B128.3 Performance of Non□Potable Water Treatment Systems

Covers package non-potable water treatment systems for wastewater or greywater intended for treatment applications, with a capacity of less than 10,000 L/d (2,650 gpd).

It will also cover site-assembled components included in packaged non-potable water treatment systems. It will specify test methods for the performance of packaged plants and minimum requirements for materials, design and construction, markings, and instructions and other documentation.

CSA B55 Series Drain Water Heat Recovery Units

B55.1 specifies requirements for measuring heat recovery efficiency and pressure loss for drain water heat recovery (DWHR) units. B55.2 specifies health and safety requirements for DWHR units. This standard is being developed in response to the need for a document that specifies safety and performance criteria for drain water heat recovery systems. It is expected to be published in the fall of 2012.

Standards Recently Revised

CSA F280-12 Determining the Required Capacity of Residential Space Heating and Cooling Appliances

This standard provides a calculation method for determining the heat loss and heat gain of buildings for the purpose of properly sizing the capacity of space heating and cooling systems and sets out restrictions on maximum output capacity of space heating or cooling appliances.

Major changes to the standard in this update include Microsoft Excel® spreadsheets for calculating heat loss and heat gain associated with all common foundations. The spreadsheets can also be used to calculate some of the factors needed to determine a building's air change, infiltration, and air leakage losses. Additional changes to this edition include calculations for determining heat loss due to continuous ventilation, air change heat loss for each room, heat gain through transparent and translucent building assemblies and heat gain adjustments for shading.

The new limit for maximum size of heating equipment has been changed to the next available equipment size above design heat loss, removing the previously allowable limit for equipment sizing to 40% above design heat loss. Because of higher performance construction practices and new energy efficiency code requirements, more airtight construction practices and HRVs, the more accurate design heat load calculations show that for many homes the heat load is very small. Where the old standard would show that a 2,400 sq.ft. house might require a 60,000 BTU furnace, the new standard shows it would be closer to 34,000 BTU.

This change has given notice to the HVAC industry of the need to refine their equipment options and develop smaller sized equipment.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
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NRC Construction Portfolio

The National Research Council is undergoing major government-mandated changes. It is refocusing its mission and priorities and will be providing more support for industry and less pure scientific research. For the construction sector, this means more support to industry and governments by means of more focused research and more responsive code development and product evaluation services. This will also mean more commercial research for private organizations and consortia that may remain under wraps.

The Institute for Research in Construction is now called the NRC Construction Portfolio and, at least for the next few years, will retain most of current research activities that will be reformulated into new programs providing enhanced capacities with higher impact. The fundamental mandate of code development and product evaluation services are not likely to change, but are planned to be supported by new competencies and more direct research to better meet current and emerging needs of both industry and governments.

Once details are worked out, it is expected that formal announcements will be made to provide more information.

Fire Performance of Houses

NRC has studied fire performance of structural products and systems used in construction of single-family houses, and the impact on occupants' ability to escape from the perspective of tenability and structural integrity. Phase 1 investigated fire performance of unprotected floor assemblies above the basement. The project was extended to examine mitigation alternatives (Phase 1b). Phase 2 was to investigate load-bearing wall systems that support the floor systems. Phase 2 work has been put on hold indefinitely.

Energy Star for Gas Furnaces

Canada has a specification for gas-fired forced air furnaces effective February 2012. Only those furnaces that have been certified by a third party as meeting requirements will appear on the Energy Star Product list. The new specifications include a minimum efficiency of 95% AFUE and 2% fan efficiency (which is the ratio of the furnace fan electrical consumption to the total energy consumption of the furnace during the heating mode).

You Asked Us:

About Spray Foam Insulation and Vapour Barriers

Many building inspectors in our region are not approving 2-pound spray foam insulation as a vapour barrier. Is this correct?

This is a question that comes up from time to time. With more spray foam insulation being used today, similar questions are becoming more common so it is important to understand the issue.

The Building Code makes it explicitly clear that ANY material with a vapour permeance less than 60 ng/Pa-s-m^2 is considered to be a vapour barrier. (NBC 9.25.4.2).

Medium density (2-pound) polyurethane spray foam products are closed cell products that have a permeance of around 40 ng for a 2" thickness - and the thicker the material, the lower its permeance, so it does qualify as a vapour barrier on its own.

A concern that is sometimes raised is about the exposed wood framing that is not covered by the foam. The concern is about how the continuity of vapour barrier is maintained. However, tests have shown that wood framing itself has a very low vapour permeance (a 2x4 has a permeance of 30 ng/Pa-s-m^2, and 2x6 - 20 ng/Pa-s-m^2). Thus, the continuity of vapour barrier is maintained.

I believe that the real concern raised is one of air barrier continuity. Again, the spray foam itself qualifies as an air barrier, as does the wood, and the adhesion of the spray foam to wood is such, that the continuity is maintained.

Thus, if anyone is not approving the use of 2-pound foam as an air or vapour barrier they are not correct.

Solar Decathlon

Since the turn of the millennium, there has been a growing movement towards net-zero housing. In the academic world, architecture and engineering students have been challenged to design, build, and operate the most attractive, effective, and energy-efficient solar-powered house. Done as a competition, the winner is the team that best blends affordability, consumer appeal, and design excellence with optimal energy production.

The U.S. Department of Energy's Solar Decathlon is an international competition that challenges 20 collegiate teams to build functioning net-zero houses. The competition is organized by the National Renewable Energy Laboratory (NREL). The first Solar Decathlon was held in 2002, and has since occurred biennially in 2005, 2007, 2009, and 2011 and was held on the National Mall in Washington DC. The next, in October 2013, will be in Irvine, California.

Open to the public and free of charge, the Solar Decathlon allows visitors to tour ultra-efficient houses, gather ideas to use in their own homes, and learn how energy-saving features can help reduce power bills.

The competition educates student participants and the public about the many cost-saving opportunities presented by clean-energy products, and demonstrates to the public the possibilities presented by cost-effective houses that combine energy-efficient construction and appliances with the renewable energy systems that are available today. For participating students it provides unique training that prepares them to enter the clean-energy workforce.

Since 2002, the Solar Decathlon has involved 92 collegiate teams, who pursued multidisciplinary course curricula to study the requirements for designing and building energy-efficient, solar-powered houses. It has established a worldwide reputation as a successful educational program and workforce development opportunity for thousands of students.

Team Canada 2011 Solar Decathlon entry. The University of Calgary team partnered with the Native communities of Treaty 7 to design a home to meet their needs and interests. Integrating technology and tradition, the house is a unique celebration of innovation and cultural diversity. http://solardecathlon.ca

Interest has grown so quickly that now there is also a Solar Decathlon in Europe, which was established by a 2007 agreement between the United States and Spain. A Solar Decathlon China, established with the signing of a memorandum of understanding between the U.S. Department of Energy, China's National Energy Administration, and Beijing University will be held in 2013.

In 2011, the University of Calgary was the only Canadian entry. In 2013, there are two: Team Alberta from the University of Calgary and Team Ontario, a consortium from Queen's University, Carleton University, and Algonquin College.

The project is open to colleges, universities, and other post-secondary educational institutions. Entry is determined through a proposal process. All proposals are reviewed, scored, and ranked. Subject to the quantity and quality of proposals, a limited number of teams will be selected for entry.

The competition is not a college lark. The requirements are aggressive. The teams are challenged to design and build a fully functional net-zero energy house between 600 and 1,000 sq.ft. in area. The house must be erected on a 4,600 sq.ft. site within a week, and must be fully functional for 10 days of public viewing, monitoring, and judging, after which time the houses must be removed.

The Solar Decathlon competition consists of ten separately scored contests. The team with the highest total points at the end of the competition wins. Teams earn points through task completion, performance monitoring, and jury evaluation. Contest rules are detailed, and the contest building regulations are comprehensive, mirroring the US Building Code.

Contest 1: Architecture

Teams are required to design and build attractive, high-performance houses that integrate solar and energy-efficiency technology seamlessly into the design. A jury of professional architects evaluates team construction documents and the final constructed house.

They evaluate three main factors: architectural elements, holistic design, and inspiration.

Contest 2: Market Appeal

For the Market Appeal Contest, teams build their houses for a target market of their choosing. Teams are then asked to demonstrate the potential of their houses to keep costs affordable within that market. A jury of professionals from the homebuilding industry evaluates how well suited each house is for everyday living, determines whether the construction documents would enable a contractor to construct the house as intended, and assesses whether the house offers potential homebuyers within the target market a good value.

Contest 3: Engineering

Solar Decathlon houses are marvels of modern engineering, and this contest "checks under the hood." A jury of professional engineers evaluates each house for functionality, efficiency, innovation, and reliability.

Contest 4: Communications

The Communications Contest awards points to teams based on their success in delivering clear and consistent messages and images that represent the vision, process, and results of each team's project. A jury of Web site development and public relations experts will evaluate the team Web sites, communications plans, and student-led house tours for effectiveness.

Contest 5: Affordability

The Affordability Contest encourages teams to design and build affordable houses that combine energy-efficient construction and appliances with renewable energy systems. A professional estimator will determine the construction cost of each house.

Teams can earn the maximum possible 100 points for achieving a target construction cost of $250,000 or less. A sliding point scale is applied to houses with estimated construction costs between $250,001 and $600,000. Houses with estimated costs that are more than $600,000 receive zero points.

Contest 6: Comfort Zone

Houses must maintain steady, uniform indoor environmental conditions. During the competition, full points are awarded for maintaining temperatures in the 22°C - 24°C range, and relative humidity below 60% inside the house.

Contest 7: Hot water

In this contest, the solar-powered house must demonstrate that it can provide all the energy necessary to heat water for domestic uses. The system must be able to deliver 15 gallons of water at an average 110°F (43°C) temperature within 10 minutes, in 16 water draws during the contest week.

Contest 8: Appliances

Appliances must mimic the appliance use and amenity in the average U.S. home while using less energy. Points are earned for refrigerating and freezing food, washing and drying laundry, and running the dishwasher.

The refrigerator must keep the temperature between 34°F - 40°F (1°C - 4°C) and the freezer -20°F – 5°F (-29°C to -15°C). The teams must successfully wash and dry 8 loads of laundry (one load = six bath towels) during contest week, and wash five loads of dishes (one load = eight place settings).

Contest 9: Home Entertainment

The Home Entertainment Contest is designed to demonstrate that houses powered solely by the sun can deliver more than just basic household functionality. They must also be able to provide a comfortable setting with power for the electronics, appliances, and modern conveniences that we love. The Home Entertainment Contest gauges whether the house has what it takes to be a home. Can it accommodate the pleasures of living, such as sharing meals with friends and family, watching television, or surfing the Web?

For this test, all interior and exterior lights are turned on at full levels at night, four cooking tasks have to be done (one task = vaporize 5 lb of water in less than 2 hours) during the contest week, and two dinner parties for up 8 guests must be organized. In addition, a TV and computer have to be operated during specified hours.

Contest 10: Energy Balance

This contest demonstrates that the sun can supply the energy necessary for all the daily energy demands of a small household. Each house is equipped with a utility meter that measures the energy the house produces and consumes over the course of the competition. A team receives full points if their house produces at least as much energy as it needs.

Information:
www.solardecathlon.gov

Federal Budget Cuts At CMHC Affect Domestic and Export Programs

Canada Mortgage & Housing Corporation was created in 1946 to house returning Second World War veterans and to lead national housing programs. Its objective was to administer the National Housing Act and the Home Improvement Loans Guarantee Act, and provide discounting facilities for loan and mortgage companies.

Although the major part of its activities is mortgage insurance and funding of social housing, the National Housing Act, an Act of Parliament, also gave CMHC a mandate to "promote the construction of new houses, the repair and modernization of existing houses, and the improvement of housing and living conditions." Under part IX of the National Housing Act, the Government is obligated to provide funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

The 2012-2016 Corporate Plan, prepared before the 2012 budget, set out CMHC's corporate objectives and strategic priorities for the next five years. It identified as Strategic Priority 3.1 a mandate to undertake comprehensive, timely and relevant research and information transfer activities to enable Canadian consumers and the housing sector to make informed decisions. It recognized that, given the highly fragmented nature of the housing sector, CMHC is one of the central sources of objective research and information that fulfils a unique role in ensuring a comprehensive outlook on key housing issues of public concern. More informed housing decisions on the part of individual Canadians and industry members, and wider adoption of best practices lead to increased market efficiency.

The construction and on-going maintenance of housing and community infrastructure have impacts on the environment, so CMHC assumed a leading role in advancing sustainable housing and communities by researching and disseminating best practices to industry and consumers, as well as promoting Canada's sustainable technologies and products globally. Adoption of these practices contributes to healthier living environments and to lowering greenhouse gas emissions.

Canada's housing system, products and services are among the best in the world, and can offer solutions for a range of housing needs in many markets abroad. CMHC has represented Canada on housing matters internationally.

Fifteen years ago, a housing export program was set up to open doors and provide technical assistance to help Canadian companies export their housing products and services abroad.

A prerequisite for successful international trade is a demonstrated generosity of spirit that encourages others to consider your offering. International trade is also a two way street, helping to cross-fertilize ideas and technologies. We in Canada, especially the current government, seem woefully short of that generosity at the present time.

Main beneficiaries of the international program were small and mid-sized companies that do not have the deep pockets of multinational corporations needed to undertake market research, networking and deciphering non-tariff regulatory barriers in various markets.

As part of the federal budget measures, and mandated cutbacks, CMHC's International export promotion is going to be discontinued, even as the government talks, in that unique doublespeak, that they remain committed to the promotion and support of Canadian exports. The international initiative was responsible for helping generate more than $100 million in export sales in 2010 by 150-200 housing exporters, and was estimated to account for more than 1,100 jobs created or maintained in Canada.

CMHC International also provided significant intelligence on international trends, construction activities and regulations which may have an impact in Canada. Once the housing export initiative cuts are fully implemented in 2015, the savings will be $10.49 million per year. Now we'll be watching others come to Canada to promote their products and services, rather than strengthening Canadian industry by helping them expand their markets. ✪

Wood Coatings

A major destructive mechanism on wood is the sun – ultra violet (UV) radiation.

UV radiation destroys the lignin in wood, which forms small water-soluble particles that can be washed out by the rain. This is noticeable in older wood when it achieves a silver appearance which then becomes a good host for destructive organisms such as mould fungi.

Paints and coatings on the exterior of buildings are used to provide weather resistance against solar radiation, water, fungi and insect attack. A variety of compounds are used, many quite toxic, not just to the destructive fungi but also to humans.

Europe has taken aggressive steps to lessen the impacts of buildings on the environment, and a number of low environmental impact products have been developed.

Boehme, a century-old Swiss coating manufacturer, has developed an eco-friendly, semi-flat, solvent free oil-stain, based on renewable resources. Their water-based, organic oil-based VOC free coatings meet the highest European Union standards. Their primary product line is marketed under the ***Bomol*** label, and has been in use for the past 25 years in Europe. They are now being introduced into Western Canada. Coatings are available for both exterior and interior use.

Canadian distributors

www.powerhousebuildingsolutions.com
www.pioneertimbercoatings.com

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Indoor Air Quality and the Respiratory Health of Asthmatic Children

Dr. Daniel Aubin

A field study investigating the impact of residential ventilation rates on indoor air quality (IAQ) and the respiratory health of asthmatic children in Québec City was recently completed by the National Research Council of Canada (NRC) and the Institut national de santé publique du Québec (INSPQ). The objectives of this study were threefold: to determine whether an increase in ventilation would lead to a corresponding decrease in the children's asthma symptoms; to correlate ventilation rates with IAQ; and to support research for determining health-based ventilation rates.

The three-year study showed that in the majority of homes, and particularly in children's bedrooms, ventilation rates did not meet the guidelines of the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE). Through the installation of either a Heat Recovery Ventilator (HRV) or an Energy Recovery Ventilator (ERV), the ventilation rates were sufficiently increased to meet the guidelines. By pre-heating or pre-cooling the incoming air as required, HRVs and ERVs enable an increased volume of outside air to come into the home, while minimizing the heating/cooling costs normally associated with natural or traditional mechanical ventilation.

In a large number of homes, the relative humidity (RH) was found to be too low in winter, which is a common problem in northern climates. Low RH levels are often associated with a negative impact on occupants' comfort and might also aggravate respiratory symptoms. Because introducing more cold and dry outside air in winter further reduces RH, low-RH homes were chosen for the installation of the ERVs (instead of HRVs) to increase the ventilation rate. The semi-permeable membrane of the ERV's heat-transfer core allows it to transfer moisture from the outgoing air to the incoming air, thus preventing the RH being further reduced in the homes. Figure 1 illustrates the effect of adding ERVs and HRVs on indoor relative humidity during the heating season (October-March) and shows that the installation of an ERV avoided the dehumidification of the home, otherwise associated with increased cold supply air rates.

Prior to the intervention, it was observed that the concentration of many pollutant gases was found to be elevated in homes with lower ventilation rates. This was also shown in the case of carbon dioxide in Figure 2, a marker for human activity that is often used as an indicator of inadequate ventilation when observed at high concentrations. There was also a marked seasonal variation in the concentration of several volatile organic compounds (VOC), with many of them being more elevated during the heating season when the ventilation rates in the homes were generally lower. Compounds which are released from building and consumer products were found at more elevated concentrations in the summer because their emission rates increase with temperature. This was the case with formaldehyde, which is a known irritant and can potentially trigger asthma. Its concentrations were observed to be much higher in summer. In summer, the formaldehyde concentrations in roughly two-thirds of the homes were found to exceed the Health Canada guideline of 50 $\mu g/m^3$ while only one-third exceeded the guideline in the heating season.

The ventilation intervention was successful in that it led to a near doubling of the ventilation rate during the heating season in the homes receiving an HRV or ERV. The interventions were also successful in that they led to a statistically significant reduction in the concentration of the number of IAQ relevant parameters. Following the intervention, the median concentrations of carbon dioxide and formaldehyde decreased by 14% and 32% respectively during the heating season for the homes receiving an HRV or ERV. There was also a notable decrease in the concentration of airborne mould spores throughout the homes. As a result of increasing the ventilation rate, all of the homes were subsequently able to meet Health Canada's formaldehyde guideline during the heating season and there was a significant reduction in the number of homes exceeding the guideline in summer. Data on the improvement of respiratory health through this intervention will be available in the fall of 2012.

This research activity was a three-year, multi-partner project between the NRC, INSPQ, the Centre Hospitalier Universitaire du Québec (CHUQ) and Canada Mortgage and Housing Corporation (CMHC). The Ministère de la Santé et des Services sociaux du Québec and Health Canada were also partners. INSPQ was responsible for coordinating the activities in the field, recruiting the participants and monitoring the health of asthmatic children. NRC was responsible for characterizing the environmental conditions, especially the IAQ and the ventilation scenario. ☼

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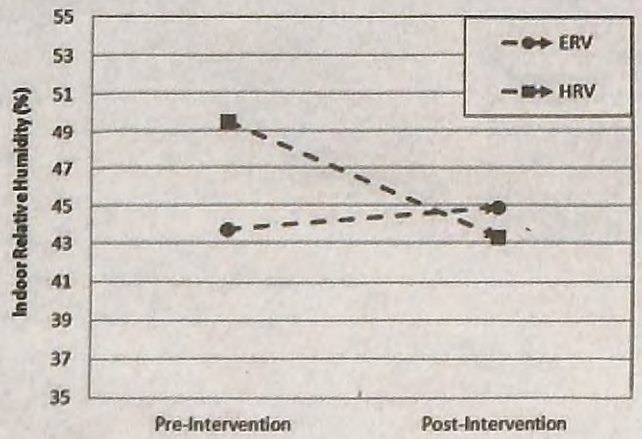


Figure 1: Average relative humidity observed during the heating season both before and after the installation of either an ERV (blue) or HRV (red) in the homes participating in the ventilation intervention.

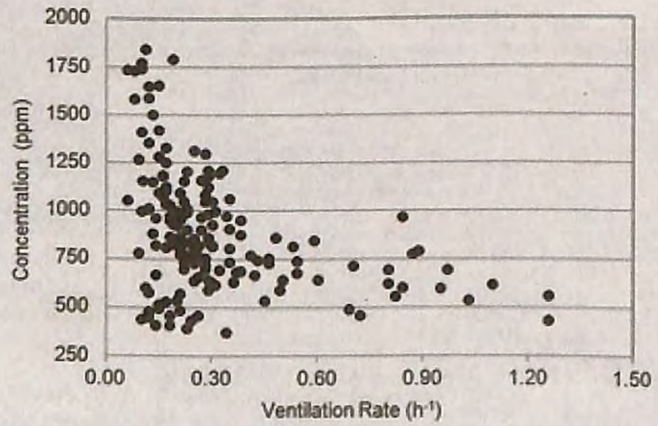
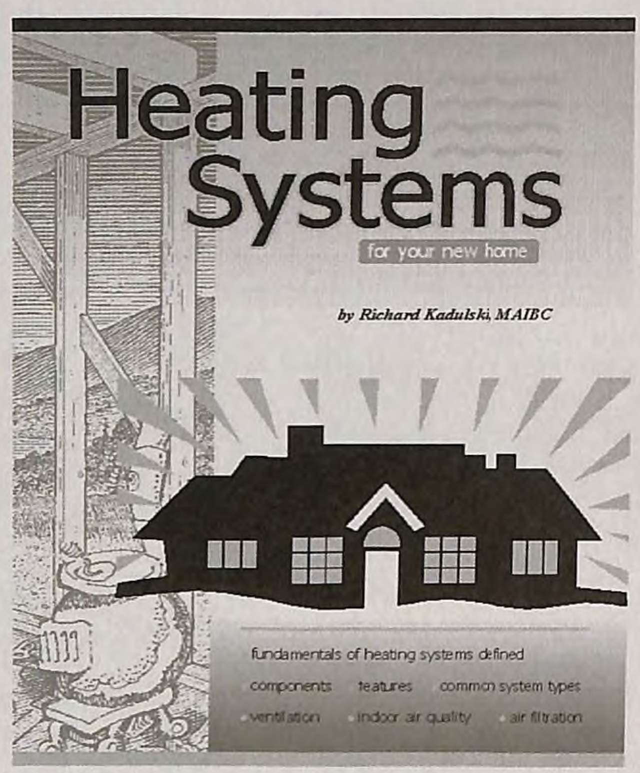


Figure 2: Concentration (ppm) of carbon dioxide measured during the heating season in the participant homes prior to the intervention as a function of the ventilation rate.



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